Analysis Protofederation Final Report

Presented To

**High Level Architecture
Architecture Management Group 14**

22 August 1996

l:\jwars\testbed\amg\amg14.ppt

Analysis Protofederation Final Report

- **JWARS HLA Objectives**

- **JWARS HLA Critical Issues**

- **JWARS/MIDAS Test Scenario**

- **Final Report Contents**

l:\jwars\testbed\amg\amg14.ppt

The final report to the DMSO High Level Architecture Architecture Management Group of the JWARS Analysis Protofederation will describe why participation in the HLA protofederation program is important to the JWARS project and what we hoped to learn from the participation.

The Analysis Protofederation team committed itself to support the resolution of the HLA Critical Issues and implemented a set of activities directed to that end. Some of the HLA Critical Issues have an important bearing on the success of the JWARS project.

The assessment of the critical issues was supported in part by a test scenario requiring the federation of the JWARS and MIDAS simulations.

JWARS HLA Objectives

- **Contribute to the resolution of HLA Critical Issues**

- **Implement HLA/RTI**

- **Examine JWARS/HLA performance**

- **Obtain JWARS/HLA scaling information**

- **Propose any new HLA requirements**

l:\jwars\testbed\amg\amg14.ppt

JWARS, as a member of the protofederation community has undertaken to contribute to the resolution of HLA critical issues. We have described our approach for doing this in previous AMG meetings.

Some of the HLA critical issues have a direct bearing on the success of the JWARS program. The examination of these issue is being done to learn the cost of HLA compliance, if any, to the JWARS project.

A further objective is to learn if there are changes or additions to the HLA requirements that, if accepted by the AMG, would benefit JWARS and other members of the modeling and simulation community.
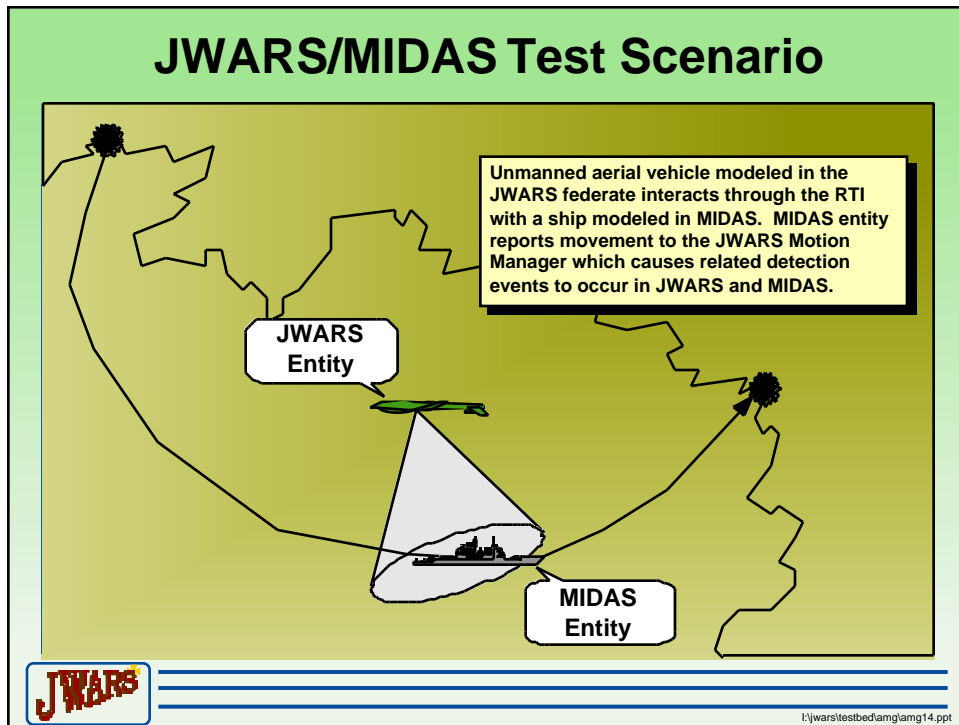
JWARS has a particular interest in the HLA Critical Issue of RTI Technical Feasibility. In particular it is important to verify that the RTI can support the repeatability requirement for analytical simulations.

In order to answer this and other questions we built a federation composed of JWARS and MIDAS federates.

Both JWARS and Object MIDAS are pure event-driven simulations. Each object instance can schedule events for itself through the Event Manager or it can schedule events for others either through the Event Manager or by direct call. The ability to execute objects through direct calls is desirable for the fine state machine models comprising the JWARS. Entity models are often composites of several objects that must be executed in a specified sequence as the same simulation time. For example, an unmanned aerial vehicle (UAV) entity may be represented by a platform object and a sensor object. If the UAV schedules a detection event, it will task the platform object to perform a move followed by the sensor object performing a sense operation. Both activities occur at the same simulation time, but clearly the results of a sense-move will be different from an move-sense. Furthermore, the sensor object will task all active target objects to update themselves to the current time and report their states. This process is more efficient and significantly less complex, if the scheduling of all the events supporting the initial UAV detection event do not go through the Event Manager.

JWARS/MIDAS Test Scenario

Unmanned aerial vehicle modeled in the JWARS federate interacts through the RTI with a ship modeled in MIDAS. MIDAS entity reports movement to the JWARS Motion Manager which causes related detection events to occur in JWARS and MIDAS.

JWARS Entity

MIDAS Entity

l:\jwars\testbed\amg\amg14.ppt

A special federation between JWARS and MIDAS was created to examine HLA issues.

The design of the federation was intended to:

> Make use of the initial JWARS prototype and the Object MIDAS

> Focus on essential simulation mechanisms

> Incorporate simple instrumentation

> Minimize complicating control elements

> Minimize data requirements

The design and implementation of this federation test case along with earlier experimentation with the RTI has provided the materials for the final report on the JWARS HLA experience.

JWARS HLA Issues

RTI Technical Feasibility

- **Parallelization, synchronization and look-ahead control**

- **"Out of Time" Messaging**

- **Time management versus Event management**

The JWARS/MIDAS test configuration was used to consider alternative ways to accomplish the execution of JWARS and MIDAS objects using the RTI time management facilities. The primary problem we encountered was the repeatable execution of multiple object instances at the same simulation time.

When the JWARS Motion Manager performed an interaction with the MIDAS ship to obtain its current state, the reply to the JWARS Motion Manager by the MIDAS ship is contained in a message that can only be released from the RTI's time stamp queue by moving forward in time to the time stamp of the message being released to the JWARS Motion Manager. To obtain the answer, the JWARS federate must submit a "next event request" and be granted a "time advance grant" to release the reply from the time stamp ordered queue. Time has then moved forward to the time stamp of the reply, invalidating the computation that was to be performed with the state information contained in the reply.

To avoid this situation, the Analysis Protofederation design sought to use time stamp ordered messaging to handle information regarding "in time" interactions and receive ordered messaging to handle information regarding "out of time" interactions.

A possible solution to the problem of event synchronization across a federation composed of distributed objects may be to replace the notion of managing the federation according to a time standard with a concept based on synchronization of federation-wide events.

The HLA simulation object model concept is directed toward a high level representation of a simulation and is directed toward depicting the parts of the simulation that will interact with other members of a federation. The emphasis is on public data exchange. No information is provided describing operations. The time management functions are best suited to simulations with single points of control for event scheduling. The definitions of attributes and associations as well as the scheduling of data exchanges is directed toward controlling data flow among the federates. This representation is very well suited to describing the operations of existing simulations and especially for exploring possibilities for reuse among members of the DIS community.

Part of the JWARS Final Report is given to a discussion of the problems we encountered when trying to represent a federation of simulations with a complex object class structure where the execution control is realized by scheduling multiple events and where the primary interaction among the objects is passing messages requiring the executions of specific methods. We found the HLA object model awkward in this environment and would like to propose extensions that would better describe simulations with similar structures.

Final Report For The Analysis Protofederation

Contents

1 **Introduction**
2 **Analysis Protofederation**
3 **JWARS System Architecture**
4 **MIDAS System Architecture**
5 **Critical Issues Overview**
6 **Detailed Discussion**
7 **Conclusion**

APPENDIX A: JWARS Simulation Ambassador
APPENDIX B: MIDAS Simulation Ambassador

l:\jwars\testbed\amg\amg14.ppt